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Research Article

Soil physicochemical characteristics and their influence on the prevalence of *Acidovorax citrulli* in diseased Watermelon plantations across selected tehsils of Jalgaon District, India

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Abstract

Bacterial fruit blotch (BFB) caused by *Acidovorax citrulli*, represents one of the most destructing diseases of cucurbits, especially to watermelon- and melon producing-regions. This study aims to explore how soil physicochemical parameters, particularly pH and water holding capacity (WHC), influence the susceptibility of Watermelon plantations to this pathogen. A total of 43 composite soil samples were collected from two major bananagrowing tehsils in the Jalgaon district of Maharashtra, India. The results demonstrated considerable variability in pH (ranging from 5.6 to 7.9) and WHC (from 35.20% to 48.90%) across the sampled sites. By integrating region-specific soil assessments with targeted amendments, it may be possible to enhance the resilience of Watermelon cropping systems. A combination of Good WHC and slightly acidic to near-neutral pH can help alleviate bacterial symptoms in watermelon plants, while high alkalinity or low WHC may foster conditions favourable to bacterial proliferation. Implementing soil monitoring and modifying soil properties could serve as effective preventive strategies against bacterial wilt in susceptible areas. Furthermore, the study reinforces emerging research on the interplay between soil health, microbial community complexity, and disease suppression. Overall, profiling soil physicochemical properties can be a valuable tool in integrated disease management strategies aimed mitigate its impact on crop production.

INTRODUCTION

Fruit crops are affected by a number of bacterial diseases, in addition to various other diseases. These diseases under favorable conditions can cause extensive yield loss in term of quality and quantity. Bacterial Fruit Blotch (BFB) affects cucurbit plants throughout the world and can be a very serious economic threat to farming community as it spreads through contaminated seeds. The disease therefore represents a serious threat to the cucurbit industry (Bahar & Burdman, 2010).

Acidovorax citrulli is a seed borne pathogen of highly destructive potential under the favorable conditions the bacterium spreads rapidly throughout nurseries in the field, leading to seedling blight or, at a later stage, fruit rot. The undersides of the seedlings' leaves displayed greasy, water-soaked patches with a yellow halo. Later, black necrotic patches appeared as the diseased areas dried out and became longer. Significant bacterial reservoirs for fruit infection were found in leaf lesions. What you want altered in this part is the lesions, which are often tiny, dark, and angled (Pawar & Papdiwal, 2009) Crall and Schenck (1969) described detailed symptoms of the watermelon fruit blotch. They reported the appearance of large, dark green, water-soaked lesions on fruits, which were accompanied by leaf spots, at an experimental station in Leesburg, FL, USA, in 1967 and 1968.

The causal bacterium A. citrulli is a Gram-negative, rod-shaped bacterium measuring approximately 0.5 µm in width and 1.7 µm in length. It is motile due to a polar flagellum about 5.0 µm long. Colonies grown on King's medium B are round, smooth, transparent, and nonpigmented. Optimal growth occurs at temperatures around 27–30 °C. Effective control strategies encompass integrated disease management aimed at minimizing the pathogen's survival and spread. The development of host-plant resistance, judicious cropping systems, soil amendments, and the use of biological control methods.

Soil pH and water-holding capacity (WHC) play a critical role in determining the survival of pathogens in the soil. Acidic conditions typically enhance pathogen survival and sporulation, with optimal pH values ranging from 3.9 to 5.5 (Wetzel and McBride, 2020). Additionally, soil moisture content is essential, as higher WHC tends to support pathogen persistence; however, excessively high moisture levels can be harmful (Specht & Murray, 1989) [18]. Jalgaon district in Maharashtra is a prominent watermelon-producing region. This study aims to offer region-specific insights into soil-pathogen interactions and to support targeted soil management strategies that can help mitigate disease risks.

MATERIALS AND METHODS

Study Area:

The research was conducted in the Jalgaon district of Maharashtra, India, a region well known for its Watermelon cultivation. Jalgaon district is generally known as 'East Khandesh' of Maharashtra State. Jalgaon district is situated in the Mid-basin of Tapi River & Sub Rivers-Girna*, Waghur, Agnawati, Bori, Anajani* & *Mor* flow through and around it. To the North side of the district Satpuda hills and to the south Ajantha-Satmala hills are present. Jalgaon is situated between latitudes 20°32′N and 21°18′N and longitudes 74°55′E and 76°28′E, featuring a diverse range of agroclimatic zones. The district experiences a tropical monsoon climate, characterized by average annual rainfall of 600-700 mm, primarily occurring from June to September. Temperatures in the region vary from 10 °C in winter to over 42 °C during the peak of summer. The soil types are diverse, ranging from black cotton soils to mixed red loam varieties, each exhibiting different drainage and fertility characteristics. This study focused on watermelon plantations located in various tehsils, including Bhadgaon and Chalisgaon, where there have been frequent reports of Bacterial Fruit Blotch caused by *Acidovorax citrulli.*

Chalisgaon is one of the prominent talukas, situated in the southwestern part of the Jalgaon district, bordering the Nashik and Aurangabad district. Chalisgaon is located at approximately 20.46°N latitude and 75.02°E longitude with an average elevation of 344meters. Situated on the Bank of Titur River, the area expriences tropical wet and dry climate. The region features a mix of Plains and land along the river and hilly landscape. The area experiences orographic rainfall. Bhadgaon is a town and taluka situated in the western part of the Jalgaon district, located at approximately 20.66° N latitude and 75.13°E longitude.

It features a semi-arid, hot climate with low rainfall.

Sample Description:

A total of 43 composite soil samples were collected from two prominent watermelon growing taluka, Chalisgaon (N=23) and Bhadgaon (N=20) of Jalgaon district in sterile zipped locked polythene bags. The samples were carefully labelled, transported in sterile containers, and stored at 4 °C until further analysis. Sampling locations were geo-tagged using GPS for spatial mapping purposes. Soil pH was calculated using pH meter, while moisture percentage and Water Holding Capacity (WHC) was determined as described (Karla, 1995).

Soil Physicochemical Analysis:

Each soil sample was air-dried, ground, and sieved through a 2 mm mesh prior to analysis. Soil pH was measured using a digital pH meter in a 1:2.5 soil-to-water suspension, following the protocol established by Jackson (1973). The Water Holding Capacity (WHC) was evaluated gravimetrically using the Keen-Raczkowski box method (Anbarasu et al. 2024). Soil texture classification was performed using the hydrometer method (Bouyoucos, 1962) and categorized according to USDA soil taxonomy. All procedures were executed in triplicate to ensure the accuracy of the data. All quantitative soil parameters were statistically analysed.

RESULTS AND DISCUSSION

This study investigates how variations in soil properties contribute to the susceptibility of Bacterial Fruit Blotch of Watermelon. Particular focus is placed on two critical parameters, soil pH and water holding capacity (WHC), as these play an essential role in determining soil health, nutrient bioavailability, and pathogen proliferation. In Bhadgaon Table I presents 20 diseased watermelon samples collected from various locations across Bhadgaon Taluka in Jalgaon District.

The aim is to analyze soil characteristics (soil type, pH, and water holding capacity) associated with diseased plants to identify possible soil-related environmental factors influencing disease occurrence. Black soils (Regur, Deep Black**,** and Medium Black**)** dominate, covering 90% of samples. These soils have high clay content and moisture retention, favorable for soilborne pathogens like *Fusarium oxysporum*, *Pythium spp.*, and *Rhizoctonia solani*. Sandy soils (low WHC) at BH12 and BH17 show lower pH and WHC, which may lead to nutrient leaching and plant stress, indirectly increasing disease vulnerability. The soils vary from slightly acidic to mildly alkaline, mostly within the optimum pH range for watermelon (6.0–7.5). Acidic soils (pH < 6.0) — BH12 and BH17 — may enhance the activity of fungal pathogens such as *Pythium* and *Phytophthora*. Alkaline soils (pH > 7.5), like BH19 (pH 8.1), may reduce micronutrient availability, leading to physiological stress and secondary infections. High WHC (>45%) soils (e.g., BH07, BH09, BH15, BH19, BH20) retain excess moisture, creating anaerobic conditions that promote root rot and wilt pathogens. Low WHC (<40%) soils (e.g., BH12, BH14, BH17, BH18) dry quickly, causing moisture stress and weakening the plant's immune response.

Table 2. represents the collection and analysis of diseased watermelon samples from 23 different locations in the Chalisgaon taluka of Jalgaon district, Maharashtra. Each sample site was characterized for: Variety of watermelon cultivated, Soil type, Soil pH and Water Holding Capacity (WHC). These parameters help understand the relationship between soil properties and disease occurrence in watermelon crops. The majority of watermelon fields were found in Medium to Deep Black soils, which are typically rich in clay and nutrients, providing good moisture retention. Sandy soils, however, were also common in the region (especially near river basins), and these soils tend to drain quickly, which can influence disease development due to uneven moisture. This indicates that soils ranged from slightly acidic to moderately alkaline. Optimum pH for watermelon growth is around 6.0–7.0; hence, most samples fall within this suitable range. The few alkaline sites (pH >7.5) such as Bahal (7.9) and Mehunbare (7.8) might influence nutrient availability and disease expression, as some fungal pathogens are favored by higher pH conditions. Higher WHC values (e.g., Mehunbare – 48.35%, Bahal – 47.50%) were observed in Regur and Deep Black soils, which retain moisture longer. Lower WHC (e.g., Bhawali – 31.70%, Shirasgaon – 33.80%) was found in Sandy soils, indicating poor water retention. K*alash* was the most frequently cultivated variety, found at multiple sites. Different varieties showed disease symptoms across various soil conditions, indicating that pathogen presence was not limited to a specific cultivar. However, variation in disease intensity may depend on each variety's genetic resistance and adaptation to soil conditions. Overall, the data suggest that while most samples from the two talukas fall within the acceptable pH range for watermelon cultivation, several outliers particularly in Bhadgaon require corrective soil management practices. Soils with high WHC, such as those in samples CH07and BH05, provide favourable conditions for watermelon production, whereas low WHC sites may compromise plant resilience unless supplemented with improved irrigation and organic matter. The present study investigates the influence of soil physicochemical parameters, particularly pH and water holding capacity (WHC), on the susceptibility of Watermelon plantations to BFB caused by Acidovorax citrulli in the Jalgaon district, specifically in the talukas of Chalisgaon and Bhadgaon. These soil characteristics play a crucial role in nutrient availability, root zone conditions, and the survivability of pathogens. Overall, the findings suggest that high WHC combined with too acidic pH can help mitigate BFB symptoms in banana plants. Implementing soil monitoring and amending soil properties could serve as effective preventive strategies against BFB in susceptible areas. Recent studies have highlighted the complex interplay between soil properties, microbial communities, and the occurrence of bacterial wilt caused by *Acidovorax citrulli*.

Soil nutrient status, particularly phosphorus, organic carbon, and nitrogen content and ratios, significantly influence disease suppression (Cao et al., 2022; Jayaraman et al., 2021). Soil moisture has been identified as a crucial predictor of disease outcomes, susceptible soils have less complex microbial interactions and fewer key microorganisms compared to healthy soil. These findings suggest that managing soil properties and microbial communities could be effective in controlling BFB. The pathogen's genomic studies have advanced our understanding of its classification, host range, and virulence factors, potentially leading to improved disease control strategies.

CONCLUSION

This study confirms that soil pH and water-holding capacity (WHC) are critical factors influencing the prevalence of *Acidovorax citrulli* in watermelon plantations. Soils with Slightly acidic to moderately

alkaline pH and high WHC provide a natural defense against BFB. In contrast, too acidic (below 5.5) and those high humidity retentions increase plant susceptibility to the disease. Implementing site-specific soil management practices can significantly mitigate disease risk. Moreover, incorporating soil monitoring into disease control strategies is essential for sustainable Watermelon cultivation.

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Table 1: Physicochemical Soil Properties (pH and WHC) of diseased watermelon plantations across Bhadgaon Tehsil, Jalgaon District, India

Sr. No.	Sample Code	Location	Site	Variety of Watermelon	Physical Properties of soil		
					Soil Type	pH	WHC
1	BH01	Bodarde	Ladkubai fort south side	Augusta	Medium black	6.8	41.20
2	BH02	Gondgaon	Shri Chakradharswami temple east side	Dragon king	Medium black	6.5	40.50
3	BH03	Gudhe	State way north side	Kalash	Medium black	6.3	41.60
4	BH04	Juwardi	Gorakhshnath temple west side	Kalash	Deep Black	6.8	44.10
5	BH05	Kajgaon	State highway east side	Augusta	Medium black	6.2	40.70
6	BH06	Kanashi	Shri Chakradharswami temple east side	Sugar king	Deep Black	6.1	43.80
7	BH07	Khedgaon	Behind MV School	Simba	Deep Black	6.7	45.40
8	BH08	Kolgaon	Kolgaon- Pohare road east side	Simba	Medium black	6.3	40.80
9	BH09	Balad	Girna river south side	Syngenta Sugar queen	Regur	7.9	48.90
10	BH10	Bambrudh	Hanuman temple east side	Augusta	Medium black	6.4	40.85
11	BH11	Nimbhore	Mahadeo temple west side	Kalash	Medium black	6.0	40.10
12	BH12	Bhorte	Kaya Petroleum North side	Syngenta Sugar queen	Sandy soil	5.7	38.30
13	BH13	Wade	Girna river south side	Ankur	Deep Black	6.8	43.90
14	BH14	Wadgaon Bk.	Pratap MV school west side	Bahubali	Medium black	6.2	39.90
15	BH15	Walwadi Bk.	Renuka mata temple east side	Syngenta Sugar queen	Deep Black	6.6	44.85
16	BH16	Warkhede	Dam upper east side	Simba	Medium black	6.3	41.65
17	BH17	Tandalwadi	Near to Shriram Nursery	Max	Sandy soil	5.6	35.20
18	BH18	Shindhi	Khanderao maharaj temple north side	Akira	Medium black	6.2	39.70
19	BH19	Pichardi	Girna river south side	Prachand	Regur	8.1	47.90
20	BH20	Utran	Girna river west side	Syngenta Sugar queen	Deep Black	6.5	44.80
			Range			**5.6-8.1**	**35.20-48.90**
			Average			**6.5**	**42.20**

Table 2: Physicochemical Soil Properties (pH and WHC) of diseased watermelon plantations across Chalisgaon Tehsil, Jalgaon District, India

Sr. No.	Sample Code	Location	Site	Variety of Watermelon	Physical Properties of soil		
					Soil Type	pH	WHC
1	CH01	Adgaon	South side	Kalash	Medium black	6.3	40.80
2	CH02	Alwadi	North side	Kalash	Medium black	6.5	39.90
3	CH03	Bahal	Girna river basin	Augusta	Regur	7.9	47.50
	CH04	Bangaon	Bangaon dam side	Sugar king	Deep black	6.9	43.60
5	CH05	Bhamare	South side	Simba	Sandy	6.1	35.20
6	CH06	Bhawali	East side	Kalash	Sandy	6.0	31.70
7	CH07	Bhoras	West side	Kalash	Deep black	6.7	45.70
8	CH08	Chinchgavhan	South side	Syngenta sugar queen	Sandy	5.9	37.45
9	CH09	Chitegaon	North side	Kalash	Medium black	6.4	40.35
10	CH10	Deoli	East side	NWMH455	Medium black	6.4	39.40
11	CH11	Deshmukhwadi	Near Busstand	Kalash	Deep black	6.7	42.80
12	CH12	Hingone	Near mahadev temple	sugar queen	Medium black	6.2	39.60
13	CH13	Hirapur	Canal side	Dragon king	Deep black	6.8	43.70
14	CH14	Karajgaon	North side	Sugar queen	Medium black	6.3	41.20
15	CH15	Mandurne	Girna river basin	Augusta	Deep black	6.9	45.10
16	CH16	Mehunbare	Girna river basin	NWMH455	Regur	7.8	48.35
17	CH17	Patonda	North side	Simba	Sandy	6.5	37.47
18	CH18	Pimpri	West side	Kalash	Sandy	6.1	36.70
19	CH19	Saygaon	Girna river basin	Max	Medium black	6.2	41.25
20	CH20	Shirasgaon	North side	Vijaya	Sandy	5.9	33.80
21	CH21	Sakur	Dam side	Kalash	Medium black	6.4	40.80
22	CH22	Takli	South side	Syngenta sugar queen	Deep black	6.7	42.80
23	CH23	Taloda	West side	Kalash	Deep black	6.9	44.25
			Range			**5.9-7.9**	**33.80-48.35**
			Average			**6.5**	**40.84**

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